The American Pacific Cable

BY ARCHER PHILIP CROUCH, written especially for the Advertiser at the request of Commercial Pacific Cable Company. Mr. Crouch is the author of "On a Surf Bound Coast," (or Cable Laying in the West African Tropics,) "Glimpses of Feverland," (a continuation of the above,) "Senorita Montenar," (a South American novel), etc. He is one of the best known writers on cables and kindred subjects.

Although it is more than fifty-two years since telegraphic communication was established between England and France by a wire submerged beneath the waters of the English Channel, the general public still knows little about the making and laying of submarine cables. The writer has several times been asked by fair inquirers if divers do not go down with the cable to lay it in its proper place. Even members of the opposite sex, whom one would expect to be better informed on the subject, have expressed a wish to know how far the cable sinks, and whether it is not necessary to attach weights to it, in order to make it reach the bottom. Others do not understand why the bottom should be reached at all, and approve of the plan once suggested by a French engineer, that the cable should be buoyed at a depth of only forty feet below the surface. They do not like to see so valuable an asset thrown overboard and left to take its chance like a shovelful of clinker, but would prefer to have it near the top, where they could pick it up in an ordinary rowing boat and make sure that it was safe and sound.

MAKING THE CABLE.

In order to do away with such erroneous impressions, it will be well to begin at the beginning and describe the component parts of the cable itself. The essential portion is the small central thread of copper, through which the electric current passes. On account of the facility with which this metal conducts electricity, the central copper wire is called a conductor. The conductor is drawn through a die together with heated gutta percha, which is thus laid on in a uniform covering. Gutta percha is the best non-conductor of electricity available for the purpose, and prevents the current leaking out from the copper wire. Tarred jute protects the gutta percha from the steel sheathing wires which form the armature. As the cable is made it is coiled into tanks and covered with water, which not only enables any incipient faults in the insulator to be detected more easily, but also forms the best medium for preserving the essential qualities of the gutta percha.

SHIPPING THE CABLE.

When the total amount of cable is nearing completion, the ship which is to convey it to its destination, is moored off the works. It is imperative that submarine cable works should be on the banks of a river or close to docks where a cable ship can lie, for it would be a costly if not impossible undertaking to transport cable by land in sections of sufficient length for submarine purposes. Temporary engines fitted up on deck haul the cable out of the factory on to the ship, where it is coiled down by hand into water-tight tanks. One man receives it and carries it within reach of his companions who are stationed round the tank. They take it from him and lay it carefully and uniformly, one turn against another. The man in the center is frequently relieved, for the work is hard, especially in the case of the larger shore-end types, which sometimes weigh as much as twenty tons per nautical mile. When all the cable is on board, final tests are taken and the ship sails for the station where the first end is to land.

SOUNDING FOR THE ROUTE.

But before a cable can be laid, careful soundings over the proposed route have to be taken. This is usually done by a smaller ship, before the arrival of the one with the cable on board. It is very important to know the contour of the ocean bed on which the cable has to lie. If no survey has been made, sufficient slack may not be paid out on nearing a submarine hill, the cable will hang in a festoon from the top of it, and eventually break with its own weight. Hemp lines used to be employed for lowering the sounder, but as these were found to be clumsy and unreliable in great depths, Sir William Thomson, now Lord Kelvin, substituted for it in 1872, pianoforte steel wire. This wire is twenty-five times less diameter than hemp, whilst its breaking strain, bulk for bulk is eighteen times as great. A sounder lowered with wire to a depth of 2,000 fathoms or two and one-fourth statute miles can be recovered in twenty-two minutes, a hemp line occupying two and one-half hours under similar conditions.

There are several forms of sounders, but the one in use by the Silvertown company—an adaptation of Captain Sigbee's, U. S. N.—possesses the essential features of the others and may be taken as a typical one. It consists of a central tube fitted with valves at top and bottom, and three smaller tubes fixed beneath the central one. As the sounder descends the valves of the central tube open upwards, and the water rushes through. On reaching the bottom both valves close, and a sample of the bottom water is brought up. The three smaller tubes sink into the ooze, and bring specimens of it to the surface for chemical analysis. In order to increase the speed with which the sounder sinks, shot weighing from thirty pounds to sixty pounds are slipped over it, becoming automatically detached on reaching the bottom.

TEMPERATURE OF THE WATER.

In soundings taken for cable purposes, the temperature of the bottom water is required, for temperatures play an important part in submarine telegraphy. A low temperature increases at the same time the conductivity of the copper wire and the insulation of the gutta percha covering, and is therefore the most suitable for cables. Faults are usually located by the electrical resistance of the conductor. It is known that the particular conductor in question gives, when in normal condition, a certain resistance per nautical mile at a given temperature. If the cable is broken so as to expose the conductor, one has only to divide the resistance obtained from the tests by the resistance per nautical mile in terms of the same temperature in order to arrive at the approximate distance of the fault from the testing station. A knowledge of the bottom temperature is therefore indispensable for accurate results, and in taking soundings a thermometer is always attached to the wire a short distance above the sounder.

Sea water follows a different law to fresh water in the relation between its density and its temperature. The density of fresh water increases with decreasing temperature down to thirty-nine degrees F., so that till this temperature is reached the coldest water is always sinking to the bottom. After thirty-nine degrees F., fresh water begins to expand again, the coldest water remains at the top, and ice forms there instead of at the bottom. This law plays a very important part in the economy of nature. Our fresh water lakes and ponds would otherwise be frozen into a solid mass in winter, and all the fish would be destroyed. As it is, the ice on the surface prevents any further loss of temperature from evaporation, and the process of freezing is greatly retarded. In the case of sea water, contraction continues, down to its freezing point twenty-five degrees F., and the coldest water is always at the bottom.

For this reason when taking a sounding a maximum and minimum thermometer gives the correct top and bottom temperature. In great depths an ordinary thermometer cannot be used, as the pressure causes an error eight degrees to ten degrees F., and has been known to cause implosion of the bulb. For deep soundings a special thermometer, the Miller-Casella is used. The bulb of this instrument is enclosed in an outer bulb filled three-quarters full with alcohol. Before sealing this outer bulb, the alcohol is warmed, so as to expel some of the air. Between the two bulbs a cushion is thus formed, which takes up the pressure, and the inner bulb remains unaffected by it.

BOTTOM OF THE SEA IS COLD.

As low temperature as twenty-seven degrees F. has been taken in the south Atlantic in the neighborhood of icebergs. Another sounding of 2,900 fathoms further north in the same ocean, gave a bottom temperature of thirty-two degrees F., the last 1,000 fathoms being described as absolutely glacial. In the second 1,000 fathoms the temperature rose to thirty-six and one-half degrees F., and in the next 500 to forty degrees F. Four hundred fathoms seems to be the limit to which the heat of the sun can penetrate. The most marked difference is at the top where the surface temperature was in one instance eighty-three and one half degrees F., while at only twenty fathoms' depth, the thermometer stood at sixty-four degrees F.

The temperature of the sea bottom between San Francisco and Honolulu, like that of the North Atlantic, averages thirty-five degrees F. The light rays of the sun penetrate only a short distance beneath the surface of the sea, and as far as extraneous illumination is concerned, the ocean abysses remain in absolute darkness. Some deep sea fish, however, have two parallel rows of small circular phosphorescent organs running down the whole lengths of their bodies, so that they resemble ships at night with double rows of shining portholes. It is thought possible by certain naturalists that portions of the sea-bottom may be as brilliantly illuminated by this kind of light as the streets of a large city after sunset.

PRESSURE AT THE SEA BOTTOM.

But the conditions which obtain at these great depths are very unfavorable to animal life. Apart from the glacial temperature, the pressure for every 1,000 fathoms is one ton to the square inch, or 160 times greater than the atmosphere in which we live. At 2,500 fathoms it is twenty times more powerful than that of the steam in an average locomotive boiler. As late as 1880, a leading zoologist explained the existence of deep sea animals at such depths by assuming that their bodies were composed of solids and liquids of great density, and that they contained no air. This, however, is not the case with deep-sea fish, which are provided with air-inflated swimming bladders. If one of these fish in pursuit of its prey ascends beyond a certain level, its bladder becomes distended with the decreased pressure, and carries it towards the surface in spite of all its efforts. This kind of misadventure may be described as falling upwards, and victims to it no doubt meet a violent death soon after leaving their accustomed level, and long before their bodies reach the surface in a distorted and unnatural condition. Even ground sharks brought up from a depth of only 500 fathoms die before they gain the sea level.

GLOBIGERINA OOZE.

Amongst the various ocean deposits, a gray ooze called "Globigerina" suits cables best, while shore deposits are the worst. The iodine contained in the seaweed found in shore deposits rapidly corrodes unprotected sheathing wires. To minimize this action, it is usual to tar or "pickle" each sheathing wire separately. Globigerina ooze is found between 1500 and 2500 fathoms but no lower, as the delicate shells of carbonate of lime of which it is composed cannot resist the dissolving action of the free carbonic acid gas in the water long enough to sink any lower. An enthusiastic cable engineer once declared that globigerina ooze had been deposited by Providence at the bottom of the sea with a special view to submarine cables, as they sink into it and are thus protected from any disturbing influences which may exist on the ocean bed.

LANDING THE CABLE.

On reaching the place selected for the landing of the cable, the ship approaches as close to the shore as possible and letting go anchor prepares to land the shore end. In some companies this is done by means of rafts, but the Silvertown method is somewhat different. A couple of spider-sheaves, or large V-shaped wheels in light iron frames are sent ashore and fixed by sand anchors some sixty yards apart. Hauling lines are paid out from the ship reeved through the sheaves and brought back on board again. One end of this continuous line is attached to the cable and the other to the picking-up gear. The engines are then set in motion, and the cable is dragged slowly out of the ship towards the shore. As it goes, large india-rubber buoys inflated with air are lashed to it every fifty or sixty feet to keep it afloat and prevent the damage which would result from it being dragged along the bottom.

When sufficient cable has been landed, the piece on shore is laid in a trench which runs from low water mark to the cable hut, and the end is inserted through a hole in the floor. Testing and speaking instruments are set up in the hut, which is occupied day and night during the laying by the electrician in charge and his assistants. When a satisfactory test has been taken the ship gets slowly under way.

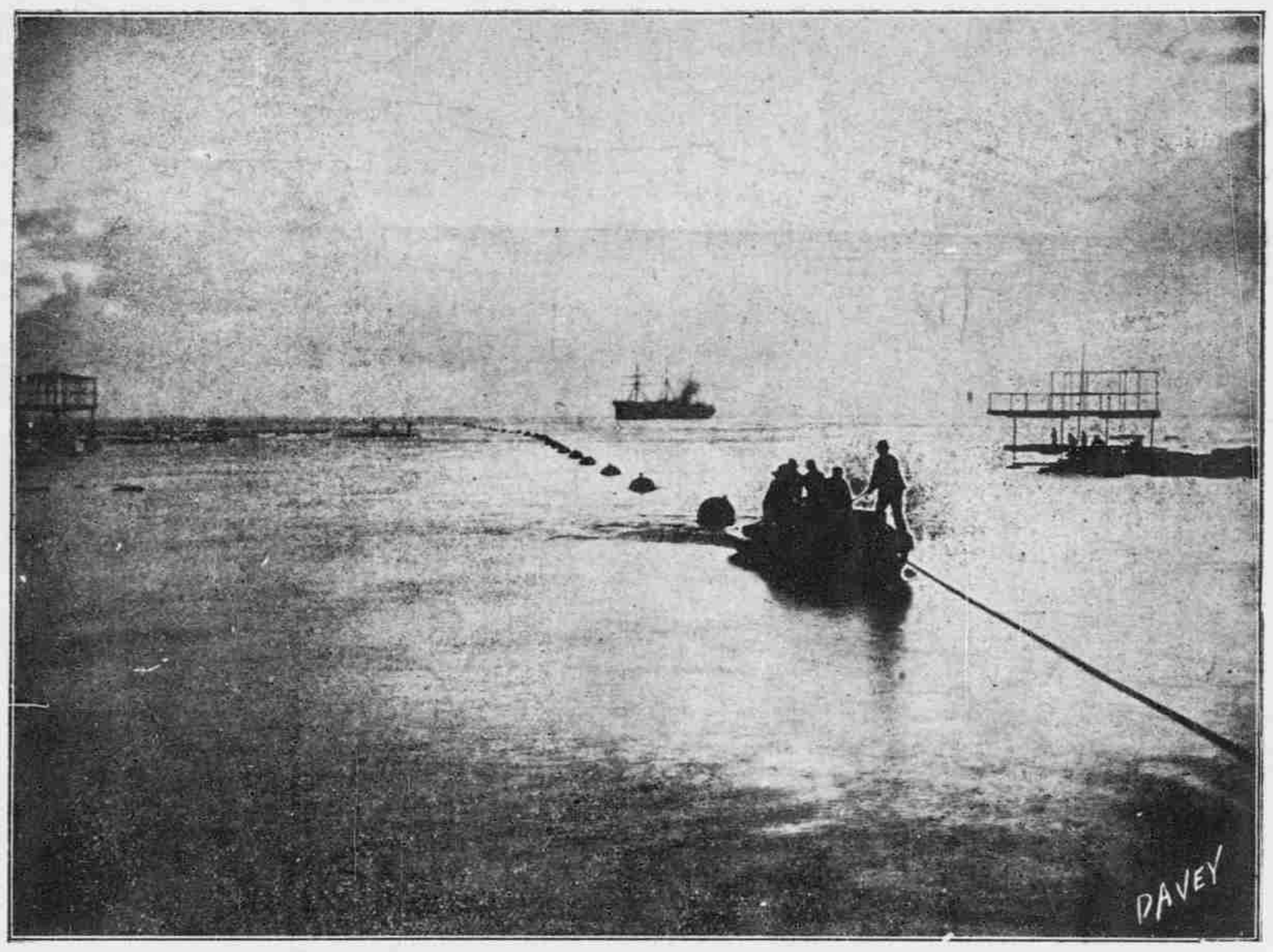
LAYING THE CABLE.

The scene on the deck of a cable ship during the commencement of paying out is full of interest to one who has not witnessed it before. The cable, being made fast on shore, drags itself out as the ship moves forward. At first it rises slowly from the tank, passing along a series of guiding troughs to the paying-out machine, round the drum of which it runs three times. Between this drum and the sheave at the stern by which the cable leaves the ship, stands the dynamometer. This machine shows the strain to which the cable is subjected, and plays an important part in cable-laying. As the water deepens the weight of cable in suspension tends to make it run out more quickly. This tendency is counteracted by increasing the weights on the brake arms of the paying-out machines. If the water shoals suddenly the weight of the cable outboard is considerably reduced, the strain lessens and the brakes have to be eased, in order to allow it to run out at the same speed as before.

The amount of cable in suspension varies according to the depth and rate of paying out. In 2,900 fathoms with the ship steaming at eight knots per hour, no less than twenty-five miles of cable are in suspension in the water. Two and a half hours are occupied in this case by any particular point in the cable, from the time of leaving the ship to touching the bottom.

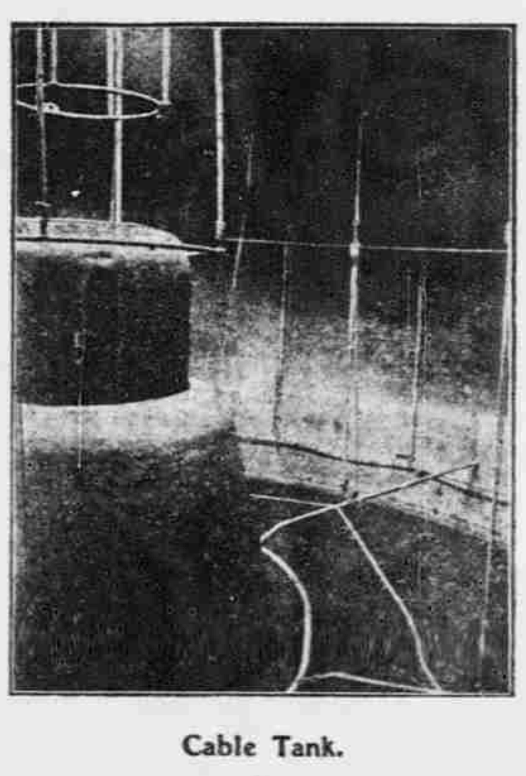
TESTING THE CABLE.

One of the most interesting spots on board a cable ship during laying is the testing room. Here in front of a table, glistening softly with the polished ebonite and bright brass terminals of various testing instruments, sits an electrician, watching a round disc of light, as it sways to and fro on a graduated scale. This disc is a reflection from the mirror of the galvanometer, and the swaying movement is caused by the induced currents set up in the coiled cable by the rolling of the ship. At the end of every fifth minute the spot gives a vigorous leap upwards on the scale, and the electrician duly notes its magnitude. This leap is caused by a signal from the shore and proves that the continuity of the conductor is still preserved. As the cable leaves the heated ship and sinks into the almost freezing temperature of the ocean bed, the insulation improves and the spot of light gradually works down towards zero. When, on the other hand, the deflection grows larger and the spot shows an inclination to steal off the upper end of the scale, something is wrong and a careful test must be taken. Should this prove that a fault exists, the ship is stopped, the cable cut, and, if the fault is near, picking up commences. If the fault is some distance away, the cable is buoyed, and the ship steams to the locality of the faulty portion.



LANDING OF CABLE AT HONOLULU.

LANDING ROPE TO HAUL IN CABLE. (Photo by Rice & Perkins.)



Cable Tank.

THE LAST STAGE.

Supposing, however, all goes well, the whole section is paid out and buoyed, and the ship steams to the second landing place. Here the shore end is landed in the same manner as before, and cable is paid out up to the buoy. When the end of the first section has been hauled on board, the splicing operation commences. This consists of (1) a joint between the two inner cores; (2) splice between the two outer sheathings. A skilled jointer with his assistant cleans and brazes together the ends of the two conductors. Then drawing down over this braze the gutta percha covering from either side, he applies two or three more coats of the same material. No air holes must be left between these different coverings, as the enormous pressure at the sea bottom might burst them and render the cable faulty. The splice in the sheathing wire is performed by cable hands, and is a much less delicate piece of workmanship.

Under the most favorable conditions cable-laying is anxious work for those in charge of the operation. At any time during the paying out—which may last with a long section some ten or fourteen days—a storm may arise or some mishap may occur on board, which results in losing the cable in a depth of over 2,000 fathoms. In such a case the date of its recovery cannot be predicted. It may be in three or four days; it may be in as many weeks or months. Every precaution is therefore taken against such accidents. Buoys are slung in the rigging ready for slipping into the water, buoy ropes and grappling ropes are coiled where they can be paid out at a moment's notice and bell pushes in connection with a bell in the engine room, are placed in convenient positions at the top of each tank.

A BROKEN CABLE.

Should the cable break out-board and be lost in spite of these precautions, a mark buoy is immediately lowered to guide the ship in grappling operations. Dragging is then begun at right angles to the line in which the cable lies. Should the dynamometer, under which the grappling rope runs, show a steady rise in the strain, the cable is evidently hooked, and heaving up commences. As soon as the grapnel reaches the bows with the bight of the cable on one of its prongs, the two sides are firmly secured, by lines from the ship, and the bight is cut. After the two ends have been tested from the testing room, the short length is abandoned or buoyed, and the other is spliced to the cable in the tanks, when paying out is once more resumed.

THE SILVERTOWN.

The telegraph steamship Silvertown which is about to lay the San Francisco-Honolulu cable for the Commercial Pacific Cable Company is the first ship that was built expressly for cable work. When launched, she was the largest merchant ship afloat with the exception of the "Great Eastern," though her cable tanks are one-third larger in cubic capacity than those of the Leviathan. The reason for their great size is that she was designed to carry a cable sheathed with hemp ropes instead of iron wires and such a cable would occupy much more space than the accepted type. If an attempt were made to fill to the brim the Silvertown's tanks with steel-sheathed cable, she would sink long before the cable reached the top of the tanks. She carries this trip 2413 nautical miles of cable, weighing 4807 tons, her total freight being between 6,000 and 7,000 tons.

MR. MACKAY AND THE CABLE SERVICE.

Business men on either side Atlantic who use the cables, are indebted to the late J. W. Mackay the excellent service which now obtains. In 1883 Mr. Mackay, together with Mr. Bennett, the well known proprietor of the New York Herald, founded the Commercial Cable Company. A pool at that time was in force amongst the existing Atlantic telegraph companies. As Mr. Mackay refused to join it, a war of rates ensued, the price being reduced from forty cents to twelve cents per word. The combination found, however, that they had to deal with a stronger man than they anticipated, and withdrew from the contest, leaving the Commercial Cable Company its independence and the rate at twenty-five cents a word. Since that date the company has always been in the van in all matters relating to telegraphic progress.

But Mr. Mackay not content with his achievements in the Atlantic turned his attention to the Pacific where he foresaw an American cable must be laid sooner or later. As far back as 1874, a Pacific cable from the States via Honolulu to Japan had been proposed, and in that year the "Tuscarora," U. S. N., under the command of Captain, now Admiral Belknap, surveyed the route. In 1879, Cyrus Field, whose name figured prominently in connection with the first Atlantic cable, renewed the Pacific scheme, but nothing more was done till the "Albatross" and "Thetis," U. S. N., were commissioned in 1891-92, to survey the route between San Francisco and Honolulu. This survey resulted in the valuable report drawn up by the then hydrographer of the United States Navy, Commander Richardson Glover. Three more years passed before the Senate voted $500,000 for the laying of this section, but the measure failed to pass in the House of Representatives. The steamer "Nero," U. S. N., surveyed the route between Honolulu and Manila in 1899. On the ratification of peace with Spain, President McKinley addressed a message to Congress, directing attention to the imperative necessity of speedy communication with the Philippines via Hawaii and Guam. "The present conditions," he said, "should not be allowed to continue a moment longer than is absolutely necessary."

The project, however, hung fire, and might today have still been as far as ever from accomplishment, if Mr. Mackay had not taken the bull by the horns, and offered to lay the cable without any subsidy whatever from Congress. Thus to the enterprise of a private individual, and not to their Government, will Americans owe the enormous advantages of telegraphic communication across the Pacific. The Silver King crowned his adventurous career with an undertaking which should earn him in history a place amongst the most public-spirited men of his day.